Self-Adjusting Biofeedback with a Dynamic Feedback Signal Set (DyFSS)

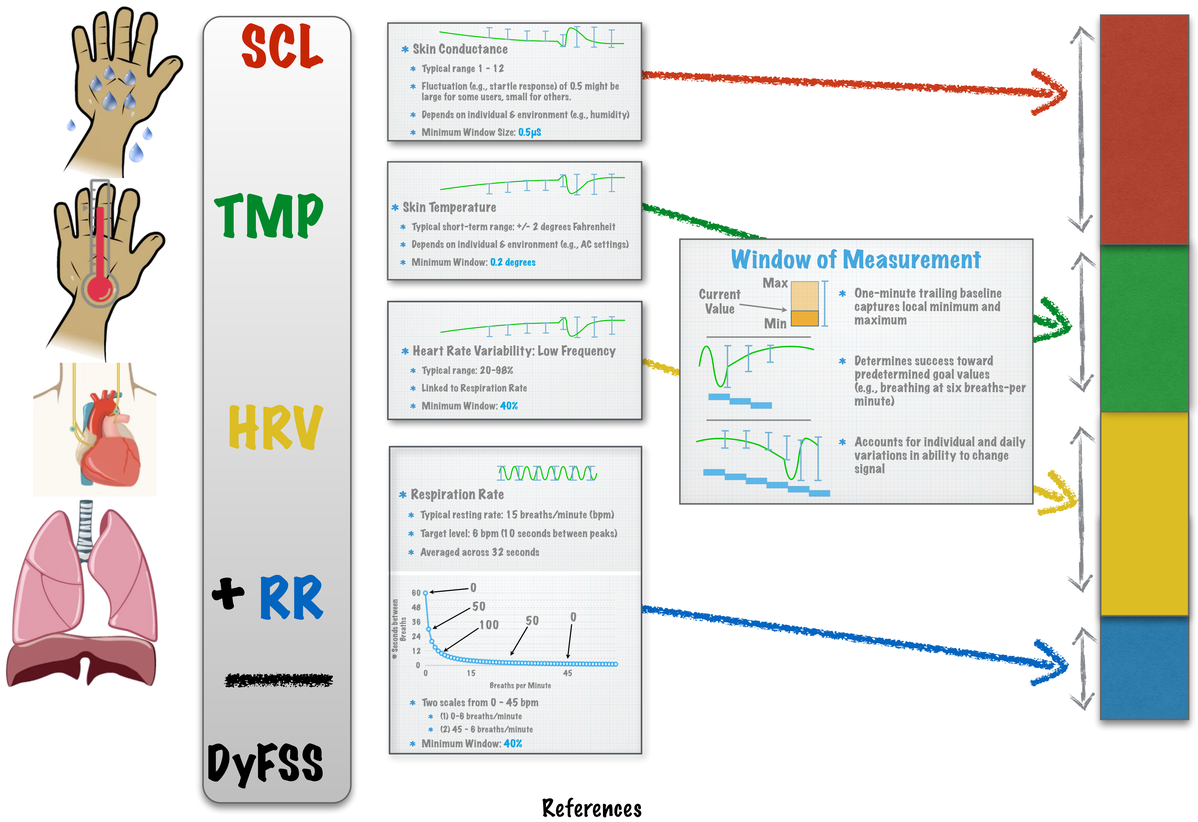
Laurence I. Sugarman[1], Brian L. Garrison[1], Anna E. Hope[1], Stephen Jacobs[2,3], Alex J. Glade[3], Michael R. Wezalis[4], Kelsey L. Williford[5]
Rochester Institute of Technology
[1]Center for Applied Psychophysiology and Self Regulation, [2]Media Arts Games Interaction & Creativity Center, [3]School for Interactive Games & Media, [4]Department of Computer Science, [5]Department of Biochemistry

Abstract

Autonomic dysregulation with anxiety presents major challenges for many children with Autism Spectrum Disorder (ASD)[1,2,3]. Peripheral Autonomic Biofeedback Training (PABT) is a promising treatment for managing both anxiety and ASD symptoms[4,5]. Diversity in ASD may also be reflected in the autonomic profile of individuals, yet there is a paucity of normative data for how the autonomic functioning may differ. Our Dynamic Feedback Signal Set (DyFSS) is a strength-based, self-customizing algorithm that addresses autonomic heterogeneity in youth with ASD. The DyFSS may ease learning of PABT by tuning sensitivity of the feedback to those inputs that are most discernible and controllable for a specific user. Feasibility was tested for youth with ASD in using this algorithm during 5-session PABT protocols. Improvement in ASD symptoms was assessed. Initial results show that youth with ASD are readily engaged through technological interventions such as autonomic biofeedback and improve problem behaviors. By creating individualized and intuitive software, PABT can be refined to address the autonomic heterogeneity of youth with ASD, ease reliance on the clinician, and create the potential for integration of PABT into interactive games and media.

What's a DyFSS?

Customarily, PABT uses inputs such as **Skin Conductance Level (SCL), skin temperature (TMP), low frequency heart rate variability (HRV), respiratory rate (RR)** and *feeds back* these signals to the user who learns how to (1) change them in adaptive directions, (2) control them, and then (3) generalize that skill to daily life. People with ASD are autonomically diverse so it is difficult to tell which sensors are best at any given time. To optimize PABT for people with ASD we took a four sensor **Signal Set** (SCL, TMP, HRV, RR) and displayed them as addends. We dynamically increased the weight of each addend as it moved in stress-reducing directions at the rate of 32 Hz, summing them to create the **Dynamic Feedback Signal Set.**



References

1. Kinsbourne, M. (2011). Repetitive movements and arousal. In D. A. Fein (Ed.) *The Neuropsychology of Autism (pp 367-394)*. Oxford University Press.
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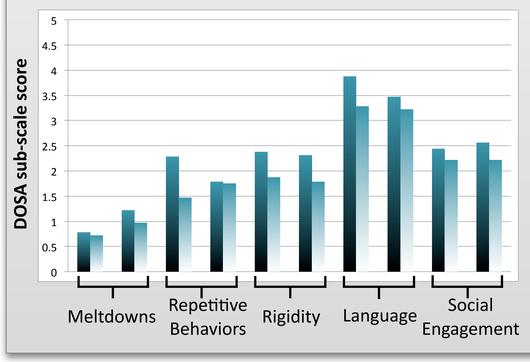
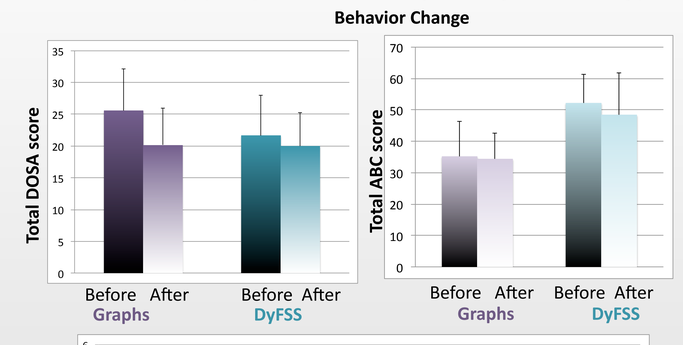
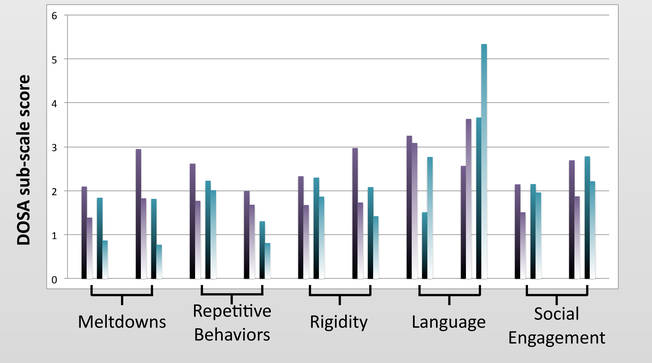
Autonomic regulation training for core features of ASD?

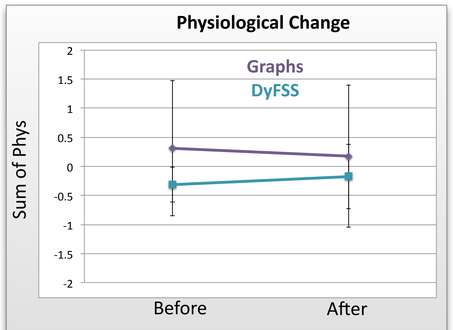
Feasibility testing of DyFSS in teens (ages 12-18) with ASD, n = 8. Change in Daily Observation Scale for Autism (DOSA), following a self-regulation training protocol. Lower scores indicate better behavior. A one-tailed, paired t-test indicates a trend toward lower DOSA scores, $t(7) = -1.7$, $p < .10$.



Comparison of DyFSS in youth (ages 8-15) with ASD to a non-customizing display of the four signals (Graphs) individually, n = 10. Change in DOSA, Aberrant Behavior Checklist (ABC), and physiological control following a self-regulation training protocol.



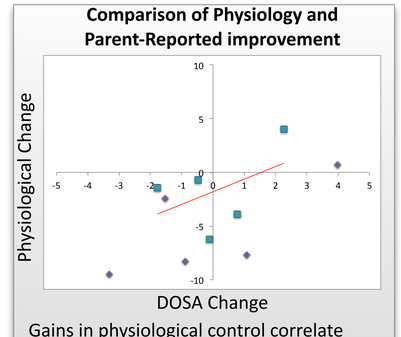




Two-factor, repeated measures ANOVA reveals little change overall in physiological control from training session 1 to 5, $F(1,10) = 0.01$, ns.

Physiological Change

The four physiological signals were first centered and normalized to accommodate for the different units of measurement. RR & SCL were inverted so all variables reflected comfort through increasing numbers. Cronbach's Alpha on the baseline measurements (n = 10) reflects that there may be some validity in considering these four signals together ($\alpha = 0.52$), though further testing will be needed to confirm. Scores reported here reflect the sum of the four normalized sensor values.



Gains in physiological control correlate strongly with parent-reported improvement in problem behaviors on the DOSA, $r = 0.56$.

Future Directions

DyFSS in ASD
Develop GUIs and orientation media
Efficacy study with behavioral, biological measures
Follow-up: Tracking symptom change, multi-site trials longer training period.

DyFSS in Other Conditions
Anxiety Disorders, PTSD
Performance improvement
Psychophysiological disorders

Integrated DyFSS
Integrate into interactive games
Portable DyFSS: glove, belt and transmitter